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published in
Journal of Flood Risk Management
2012

DOI (link to publisher)
10.1111/j.1753-318X.2012.01151.x

document version
Publisher's PDF, also known as Version of record

Journal of
Flood Risk Management

Do flood risk perceptions provide useful insights for flood risk management? Findings from central Vietnam

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DOI: 10.1111/j.1753-318X.2012.01151.x

Key words
Behaviour; flood; precaution; risk mitigation measures; risk perception; Vietnam.

Abstract

Following the renewed attention for non-structural flood risk reduction measures implemented at the household level, there has been an increased interest in individual flood risk perceptions. The reason for this is the commonly-made assumption that flood risk perceptions drive the motivation of individuals to undertake flood risk mitigation measures, as well as the public's demand for flood protection, and therefore provide useful insights for flood risk management. This study empirically examines these assumptions by presenting data from a survey conducted among 300 households in central Vietnam. The main implications for flood risk communication and the stimulation of precautionary behaviour are that the current predominant focus on flood risk perceptions in the academic literature, and risk communication policy is not supported. Hence, the study provides an important contribution to the existing literature that mainly studies flood risk perceptions in developed countries.

Introduction

Floods are frequently causing substantial social and economic losses worldwide (CEA, 2007; Tran *et al.*, 2010; Munich Re, 2011). In recent decades, non-structural flood risk reduction measures[1] implemented at the household level, such as waterproofing of buildings, adapted use, or the deployment of mobile flood protection devices, have received renewed attention, both in the European Union (EU) and in the developing countries (ICPR, 2002; Few, 2003; Brouwer *et al.*, 2007; Kreibich *et al.*, 2011). In the EU, this renewed interest results from the renunciation of predominantly technical flood protection approaches toward more integrated risk concepts (e.g. Büchele *et al.*, 2006; European Parliament and the Council of the European Union, 2007; de Moel *et al.*, 2009). The latter take into account that technical flood defences might fail and therefore also consider means to reduce the consequences of potential flooding. Moreover, it is increasingly acknowledged that technical flood defence measures need to be complemented by non-structural flood risk reduction measures because of the projected increase in flood risk in many regions due to climate change and on-going development in flood-prone areas (Nicholls *et al.*, 2008; Kummu *et al.*, 2011; te Linde *et al.*, 2011), as well as the considerable uncertainties associated with these developments (de Moel and Aerts, 2010). In developing countries, the mixed success of structural flood protection measures has added further impetus to the tendency to increasingly focus on interventions on both the household and the community level to reduce the impacts of flooding (Few, 2003; Asian Disaster Preparedness Centre, 2006; Brouwer *et al.*, 2007). In addition, developing countries often have limited financial resources to bear the considerable costs of providing flood protection measures on a large scale and will thus rely on other means to reduce the impacts from flooding (Few, 2003).

The shift to integrated risk management concepts has been accompanied by a growing interest in individual and societal flood risk perceptions (e.g. Siegrist and Gutscher, 2006; Botzen *et al.*, 2009a; Kreibich *et al.*, 2009; Terpstra *et al.*, 2009). Flood risk perceptions are defined in the present paper as follows: 'perceived risk' relates to the combined measurement of 'perceived probability' and 'perceived consequences' of a possible flood event. In addition, in this paper, we refer to the two single facets of the term 'perceived risk': namely the 'perceived probability' (or likelihood) and the 'perceived consequences' of a possible flood event. 'Risk perceptions' is used as the generic term and relates to all three definitions. Risk perceptions are commonly studied because it is assumed that they can provide useful insights

[1]Non-structural flood risk reduction measures are defined in this paper as any measures taken at the household level that reduce flood risk.

for the development of flood risk management policies (e.g. Kellens *et al.*, 2011). In this respect, two important aspects will be discussed and empirically investigated in this study. First, high flood risk perceptions of an individual are often assumed to be related to a higher motivation to undertake flood risk mitigation measures (Plapp and Werner, 2006; Plattner *et al.*, 2006). Second, individual risk perceptions are also taken into account by policy makers and influence public policies that address risks (Sjöberg, 2001; Kellens *et al.*, 2011). Risk perception ratings could, for instance, provide an indication for policy makers of the type of risks that are perceived as high by society and should therefore be reduced by governmental policies.

However, a growing number of studies do not in fact support the assumption that risk perceptions *per se* provide useful insights for flood risk management. A review of peer-reviewed studies that empirically investigate the relation between individual flood risk perceptions and mitigation behaviour shows that this link is hardly observed (Bubeck *et al.*, 2012). A possible explanation for this is that the feedback from already-adopted mitigation measures on risk perceptions is often not accounted for in these studies (Weinstein *et al.*, 1998). Moreover, Sjöberg (1999) showed, for several empirical studies and various risks, that risk perceptions *per se* do not necessarily provide information on the public's demand for risk reduction policies. He shows that only a certain aspect of risk perceptions provides useful insights into demand for risk reduction: namely the perceived consequences of a hazard (Sjöberg, 1999, 2000).

A main limitation of the current literature on flood risk perceptions and mitigation behaviour is that these studies have been predominantly conducted in Europe, the USA, and other developed countries (e.g. Grothmann and Reusswig, 2006; Siegrist and Gutscher, 2006; Lindell and Hwang, 2008; Miceli *et al.*, 2008). Studies from developing countries are mostly lacking, while such studies are important to confirm whether the main findings of studies in developed countries also apply in a different socio-economic and cultural environment. This lack of knowledge on individual risk perceptions and mitigation behaviour in developing countries is problematic, as it is especially these countries that already face major impacts from flooding (Few, 2003; Tran *et al.*, 2010).

This study presents the results from a recently conducted survey using face-to-face interviews with 300 respondents in a flood-prone province in central Vietnam. The data provide new insights into the relation between flood risk perceptions and flood risk mitigation behaviour when controlling for already-adopted mitigation behaviour in cross-sectional studies; the relevance of risk perceptions for risk management policies in terms of the public's demand for risk reduction policies; and the transferability of findings of existing studies to a developing country like Vietnam. The remainder of this article proceeds as following. The second section reflects in more detail the usefulness of flood risk perceptions for flood risk management. The third section presents the results of the survey conducted in Thua Thien Hue province in central Vietnam, including a discussion of the findings. Finally, the fourth section concludes on the implications for risk communication and for policies that aim to encourage private precautionary behaviour.

Flood risk perceptions and risk management

The relation between individual risk perceptions and flood risk mitigation behaviour

Following the renewed attention for non-structural flood risk mitigation measures implemented at the household level, there has been an increased interest in the socio-economic and perceptual factors that influence precautionary behaviour (Siegrist and Gutscher, 2006; Thieken *et al.*, 2007; Terpstra *et al.*, 2009; Zaalberg *et al.*, 2009). Most research on perceptual factors focuses on flood risk perceptions (Grothmann and Reusswig, 2006). This can be explained by the assumption that individuals with high flood risk perception are more likely to undertake flood risk mitigation measures than others. However, this is not supported by the majority of studies that have examined the relation between flood risk perceptions and mitigation behaviour as these studies found no or only a statistically weak relation (for an overview, see Bubeck *et al.*, 2012).

One explanation for this that has been put forward in the literature refers to a methodological aspect of risk perception research (Weinstein *et al.*, 1998): apart from a few exceptions (Terpstra *et al.*, 2009), the available studies are cross-sectional in nature and investigate the relation between risk perceptions and already-performed flood risk mitigation measures for a certain sample group at one specific moment in time. However, such a study design does not account for the feedback of an already-adopted flood risk mitigation measure on the risk perceptions of a respondent. The risk perceptions of an individual who has implemented a mitigation measure are likely to decrease after the measure has been installed (Weinstein *et al.*, 1998; Grothmann and Reusswig, 2006). If this individual is then included in a cross-sectional survey, the relation between the initially high-risk perceptions and the already-performed mitigation measures can therefore no longer be detected (Weinstein *et al.*, 1998).

To overcome this methodological shortcoming, and to gain a more accurate picture of the relation between risk perceptions and mitigation behaviour, it has been proposed

in the literature to ask respondents for their *intentions* to undertake a measure (Weinstein *et al*., 1998). By eliciting behavioural intentions, the relation between the two variables is not disturbed by the feedback of an already-adopted mitigation measure. The few studies that take this methodological aspect into account and elicit mitigation intentions detect a statistically significant positive relation with mitigation behaviour (Botzen *et al*., 2009b; Zaalberg *et al*., 2009; Terpstra, 2011). This suggests that controlling for prior mitigation behaviour can solve the methodological problem of the cross-sectional research design, and can more accurately detect the relation between risk perceptions and precautionary behaviour. Nevertheless, it should be noted that those studies that do control for past mitigation behaviour also find a rather weak relationship with risk perceptions (e.g. Botzen *et al*., 2009b).

Risk perception as an indicator for risk management policies

In addition to the empirical finding that flood risk perceptions are a rather weak indicator for mitigation behaviour (Miceli *et al*., 2008), there are other reasons to question the importance of risk perceptions *per se* for the understanding and management of risk in policy contexts. The argument provided below thereby refers explicitly to eliciting the perceived risk, and thus the combined measurement of perceived probability and perceived consequences.

In general, it can be expected that politicians are to a considerable degree influenced by the public opinion. Also, the risk perception ratings of the public are taken into account by policy makers and influence policies that address risks (Sjöberg, 2001, 2002). Risk perception ratings could, for instance, provide an indication for policy makers of the type of risks that are perceived as high by society and should therefore be reduced by governmental policies. Risk perceptions could thus be used as an indicator for the public's demand for (flood) risk reduction policies. Also in Thua Thien Hue province, the public opinion and risk perceptions are considered during the policy process. An example of this is the recently adopted 'Action Plan on Climate Change'. This action plan was drafted by the Department for Natural Resources and Environment (DONRE) in cooperation with a local non-governmental organisation and took into account the findings of a survey among local communities on risk perceptions and adaptation priorities, as well as additional input from stakeholders (DONRE and CSRD, 2010). However, Sjöberg (1999) points out that ratings of perceived risk by individuals predominantly reflect the perceived probability of an event and hardly ever the perceived consequences. A number of empirical studies have demonstrated, however, that the demand for risk reduction is predominantly related to the perception of the consequences of an event (Sjöberg, 1999, 2000). Therefore, ratings of perceived risk, which mainly reflect probability ratings, are mostly irrelevant if one tries to understand and to advise on policy regarding the public's priorities for risk reduction policies. Insights on this aspect need instead to be drawn from the ratings of perceived consequences.

Case study in central Vietnam

To obtain further insights into the relevance of flood risk perceptions for flood risk management, we address the aforementioned research gaps in an empirical survey that delivers three main innovations. First, to avoid the methodological problem discussed above, we examine the relation between flood risk perceptions and the *intention* of respondents to adopt flood risk mitigation measures.

Second, it was discussed that insights into the public's risk tolerance and consequently the public's demand for risk reduction policies are mainly provided by the perceived consequences. However, it has not yet been studied whether this finding applies to those respondents who actually face flood risk, which will be specifically examined in this study.

Third, previous research on the relation between flood risk perceptions and mitigation behaviour and the public's demand for risk reduction policies comes predominantly from Europe and the USA (e.g. Sjöberg, 1999; Grothmann and Reusswig, 2006; Miceli *et al*., 2008). To complement this work, and to gain insights into whether findings can be generalised cross-culturally, we present data from central Vietnam, which is a region that is heavily impacted by floods.

Study area

Thua Thien Hue is a coastal province located in central Vietnam with a total area of approximately 5000 km^2 (Figure 1). The West of the province borders the Lao People's Democratic Republic, and is characterised by the Truong Son Mountain Range with peaks of up to 1346 m ('Don Pho peak'). The coastal plains and the Tam Giang lagoon are located in the East of the province. The most important river in the province is the Huong (Perfume) River that flows into the lagoon and eventually drains into the Pacific. The largest city of the province is Hue, which is a United Nations Educational, Scientific and Cultural Organization world heritage site. Currently, about 1.31 million people inhabit the province, of whom 330 000 reside in the city of Hue (Tran and Shaw, 2007; Tran *et al*., 2009). The province is prone to natural disasters, and has frequently been affected by flooding, typhoons, and droughts. Between 1975 and 2005, 40 flood events occurred along the Huong River. The most disastrous flood happened in November 1999 during a typhoon, which inundated 90% of the

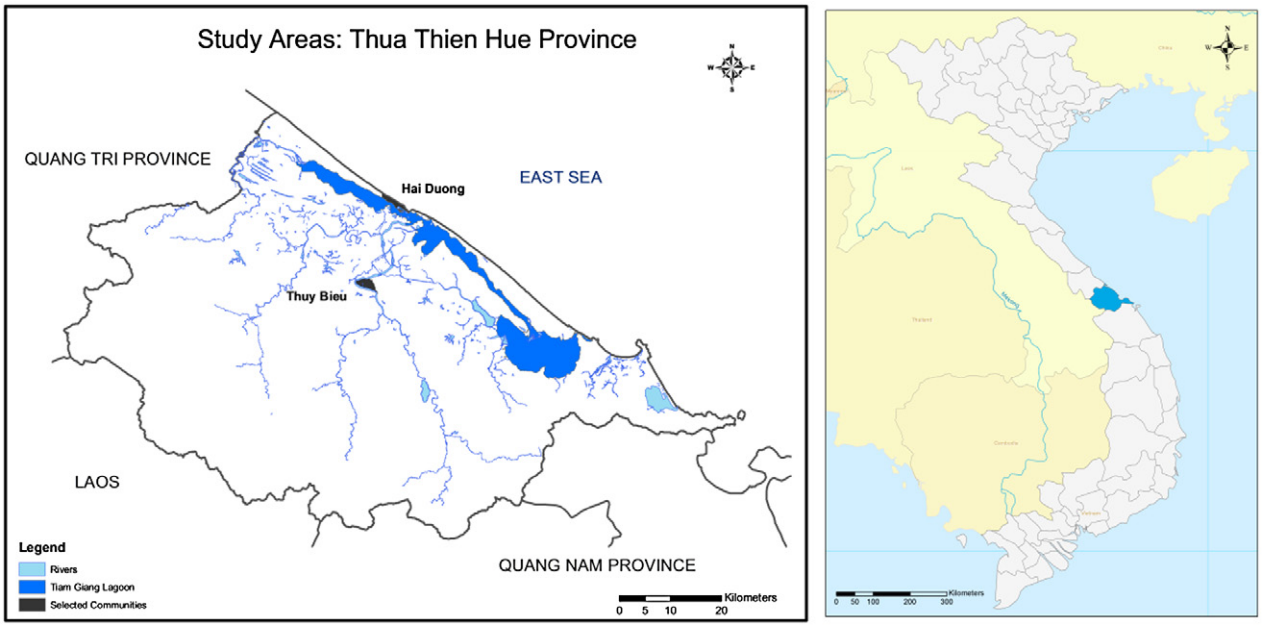

Figure 1 Case study area in Vietnam.

lowlands and lasted for 1 week. In total, 352 people were killed, 25 000 houses were washed away, and about 160 000 cattle died. In total, the flood caused direct damage costing as much as USD 120 million, which is an enormous amount for a developing country (Tran and Shaw, 2007; Tran *et al.*, 2009).

Method and sample characteristic

To gain further insights into the usefulness of flood risk perceptions for flood risk management, a questionnaire was developed that contained the following four sections: (1) personal and household characteristics; (2) questions on risk perception; (3) knowledge and expectations about climate change; and (4) experience of, and adaptation to, natural disasters. A complementary report on the qualitative results of the study can be accessed under http://www.adapts.nl/publications/. Before implementing the main survey, the questionnaire was pretested by local interviewers with 90 respondents in a neighbouring province in Vietnam. The pretest was conducted to test the questionnaire and to make sure that the respondents were able to easily understand the questions. As a result of the pretest, a question on the perceived frequency of floods was removed from the questionnaire because it was perceived as repetitive and difficult by the respondents. The pretest showed that the other questions were not too difficult for respondents. Subsequently, the main survey was administered in the two communes using face-to-face interviews by trained and experienced local interviewers, both male and female. Thuy Bieu commune lies on the banks of the Perfume River in the vicinity of Hue city, and Hai Duong commune is situated close to the lagoon and the sea (Figure 1). In August 2009, 150 people were interviewed in each of the two communes, which resulted in a total of 300 respondents. The age of the respondents ranges from 20 years to 87 years, with an average of 49.8 years. With 53.7%, slightly more women participated in the survey than men. The two communes have been selected as our sample area because they are geographically and socio-economically representative for Thua Thien Hue province. In particular, Hai Duong faces flood hazards from both the sea and the lagoon, and Thuy Bieu faces a flood hazard from the Huong River, which means that the main causes of floods in Thua Thien Hue province (sea, river, and lagoon) are present in our sample area. Moreover, by choosing respondents from Hai Duong and Thuy Bieu, the sample mirrors the predominant livelihoods of people living in Thua Thien province. The livelihoods varied in the two communes because of differences in their location. In Hai Duong, the people's main source of income is fishing (40%) and aquaculture (20%). Moreover, 17% make a living from rice farming, and 34% provide small services. In Thuy Bieu, the family's income is generated from rice (26%) and crop farming (20%), or from growing perennial plants (19%), while 38% of the families earn their living from running small businesses. People in both communes live, on average, 300 m away from the river, ranging from the river bank up to 2 km away from the river. In Hai Duong, people also live very close to the sea (mean distance = 428 m), which indicates the high vulnerability of this commune.

Results and discussion

Risk perceptions and the intention to adopt flood risk mitigation measures

To examine the role flood risk perceptions play in prompting actual mitigation behaviour, the 300 respondents were asked to rate their (1) perceived probability and (2) their perceived consequence of potential future flooding, on a scale from 1 to 7. A rating of 1 indicates that a flood event will not happen at all and that it therefore has no consequences at all, while a rating of 7 indicates that a flood event will definitely happen and that the consequences of a flood are considered to be extremely high. Both the mean rating and the standard deviation were found to be higher for the item perceived probability (mean = 5.67 and standard deviation (SD) = 1.69) than for the perceived consequences (mean = 5.36 and SD = 1.23). Overall, risk perceptions are high, with mean scores above 5. The fact that the perceived probability has a higher standard deviation indicates a larger variability in responses, which is in line with the literature that shows that individuals find it difficult to rate probabilities (Viscusi, 1998). A comparison between the two communes by means of the Mann–Whitney Test revealed that no significant difference exist for the variable perceived probability. A significant difference ($P < 0.03$) was found for the variable perceived consequence between the two communes. With a mean rating of 5.54, respondents in Hi Duong associated higher consequences with floods compared with respondents in Thuy Bieu (mean = 5.19). This can most likely be explained by the higher destructive power of coastal floods compared with river floods (e.g. Nadal *et al.*, 2010), as well as the high vulnerability of the commune, which is located on a thin stretch of land between the lagoon and the sea.

To gain further insight into the effect of controlling for previously adopted flood risk mitigation measures, respondents were also asked about their *intention* to perform such measures in the future. A rating of 1 indicates that the respondent definitely does not intend to undertake a mitigation measure, while a rating of 7 indicates that the respondent definitely does intend to do so. As can be seen in Table 1, more than 20% of the respondents will 'very likely' or will 'definitely' undertake a flood risk mitigation measure, while 37% answered that this is 'likely'. This indicates that many respondents are interested in undertaking flood risk mitigation measures in the future.

Table 2 presents the results of a correlation analysis of the intention to undertake a mitigation measure and the two dimensions of flood risk perception. Spearman correlations are provided to account for the non-parametric distributions of the variables. Both risk perception dimensions have a small to medium correlation with the *intention* to undertake flood mitigation. The fact that statistically significant correlations are found for the item perceived probability, in contrast to almost all studies measuring this relationship (e.g. Kreibich *et al.*, 2005; Miceli *et al.*, 2008; Thieken *et al.*, 2006; Knocke and Kolivras, 2007), suggests that it is important to control for previously adopted mitigation behaviour. The findings are in line with other studies on flood risk perceptions that also control for previously adopted mitigation behaviour and that did also find significant, although rather weak, relations between risk perceptions and mitigation behaviour (for an overview of such studies, see Bubeck *et al.*, 2012).

In addition to the correlation analysis, we performed a multiple regression analysis because it provides additional information by predicting the intention to undertake a measure from the two dimensions of risk perception. The results are presented in Table 3. It is shown that both risk perception items are rather weak predictors of the intention to perform flood mitigation measures because the model can only explain 3.2% of the variance in the intention to mitigate. The perceived probability makes no significant contribution to the model. The results are comparable with other studies. Grothmann and Reusswig (2006) find that risk perception explains only between 3% and 6% of the variance in

Table 1 Intentions of respondents to undertake a flood mitigation measure in the future

Answer category	% of responses
Definitely not	3.7
Very unlikely	11.7
Unlikely	20.4
Neutral	7.7
Likely	36.8
Very likely	5.0
Definitely	14.7

Table 2 Correlations of intentions to mitigate with two components of risk perception

	Probability	Consequence
Intention to mitigate	0.222**	0.144**

**Correlation statistic is significant at the 1% level (one tailed).

Table 3 Regression analysis for the 'intention to mitigate' with two components of risk perception

	Coefficient	Standard error	*P*-value
Constant	3.014	0.461	0.00
Perceived consequence	0.118	0.060	0.05
Perceived probability	0.126	0.084	0.13

Note: $R^2 = 0.03$.

Table 4 Correlations of demand for risk reduction with the two dimensions of flood risk perception

	Perceived probability	Perceived consequence
Demanded mitigation	0.406**	0.474**

**Correlation statistic is significant at the 1% level using a one-tailed test.

Table 5 Regression analysis of the demand for risk reduction with the two dimensions of flood risk perception

	Coefficient	Standard error	*P*-value
Constant	2.736	0.265	0.000
Perceived consequence	0.455	0.048	0.000
Perceived probability	0.090	0.035	0.010

Note: $R^2 = 0.31$ ** $P < 0.001$.

mitigation behaviour. Lindell and Hwang (2008) report that the perceived probability can only explain 1% of the variance in mitigation behaviour and 5.5% of the variance in the purchase of flood insurance. The fact that similar results were obtained in a completely different socio-economic and cultural setting suggests that the findings can be generalised cross-culturally.

Risk perception and the demand for risk reduction

It was suggested above that insights into the risk tolerance, and consequently the public's demand for risk reduction policies by governmental policies, should not be drawn from risk perception ratings, as such, but from ratings of the perceived consequences. Until our study, this relationship has, to the best of our knowledge, not been established for a sample group facing flood risk in a developing country. Respondents were, therefore, also asked to indicate their demand for flood risk reduction, on a scale from 1 to 7. A rating of 1 indicates that the respondent considers it as not important at all to prevent or alleviate the negative impacts of floods, while a rating of 7 indicates that the respondent finds this extremely important. Table 4 presents the results of a Spearman correlation analysis between the general demand for flood risk reduction and the two dimensions of risk perception. It is shown that the demand of respondents for reducing the negative effects of flooding is significantly related to both the perceived probability and the perceived consequences of a flood. The perceived consequences are slightly more highly correlated with demand for mitigation than the perceived probability. Therefore, on the basis of the correlation analysis, the hypothesis that it is predominantly the perception of the consequences of a flood event that drives the demand for risk reduction is weakly supported.

Next, we perform a multiple regression analysis because it allows us to predict the demand for flood risk reduction using the two dimensions of risk perception. The results are given in Table 5. It is shown that the item 'perceived consequence of a flood' is a much better predictor of the general demand for flood risk reduction than the 'perceived flood probability', as was suggested by Sjöberg (1999, 2000). Both variables make a significant contribution to explain the demand for risk reduction. The model explains 31% of the variance in the demand for flood mitigation, which indicates a strong explanatory power based on standards in psychological research (Grothmann and Reusswig, 2006). The results are in accordance with previous empirical findings (Sjöberg, 2000), which again suggests that they can be cross-culturally transferred.

Conclusion

Flood risk perceptions have received growing attention in recent years owing to the assumption that they provide useful insights for flood risk management. To gain further insights into the relevance of flood risk perceptions for flood management in terms of precautionary behaviour, as well as the public's demand for flood protection, we have presented data from a survey among 300 residents of flood-prone areas in central Vietnam. In contrast to the vast majority of other studies, we find weak to medium correlations between the perceived probability and the perceived consequence of flooding and the *intention* to adopt flood mitigation measures. This suggests that controlling for already-adopted mitigation measures in cross-sectional studies can more accurately capture the relation between risk perceptions and mitigation behaviour. Nevertheless, multiregression analyses confirm that flood risk perceptions are rather weak predictors of precautionary behaviour, even when previous mitigation behaviour is controlled for by eliciting behavioural intentions. In addition, our findings support earlier empirical studies that showed that knowledge of flood risk perceptions *per se* does not necessarily provide useful insights for flood risk management. The results based on our sample of households who face flood risk support the hypothesis that insights into the public's demand for risk reduction policies are mainly provided by the perceived consequences of flooding.

Our results have important implications for risk communication policy and the stimulation of private precautionary behaviour. In line with the present focus of the literature on risk perceptions, raising flood risk awareness is currently being considered as an important policy tool to increase the preparedness of people at risk from flooding. Our findings suggest, however, that increasing risk awareness *per se* is not a promising approach to achieve improved protection against flooding. Other factors, such as flood-coping appraisals, have been consistently found to provide more explanatory power in terms of precautionary behaviour (e.g.

Grothmann and Reusswig, 2006). Flood-coping appraisal refers to the individuals' perception of the effectiveness of flood mitigation measures, their perceived ability to actually implement such measures, and the perceived costs in terms of time, money, and emotions of mitigation measures. Therefore, flood risk communication should provide information on the cost-effectiveness of flood mitigation measures, as well as practical guidance on how to implement them. Moreover, future research on flood risk mitigation behaviour should increasingly focus on other perceptual variables than risk perceptions, such as flood-coping appraisals.

This study is a useful contribution to the existing literature that predominantly comes from the USA and Europe because insights are provided into whether the findings of previous studies can be generalised cross-culturally. Because the results of the Vietnam survey are in line with analyses of data from Europe and the USA, it may be suggested that insights can be generalised cross-culturally. However, more research on the comparability of empirical findings between developed and developing countries in terms of factors that stimulate precautionary behaviour are needed. This is especially important given the already high exposure of developing countries to flooding today and the projected increase in flood risk in the years to come.

Acknowledgements

The authors would like to thank the editor and two anonymous reviewers for their valuable comments. The study in central Vietnam was carried out within the ADAPTS project (http://www.adapts.nl/), which is funded by the Directorate General for International Cooperation (DGIS) of the Netherlands Ministry of Foreign Affairs. Wouter Botzen received co-funding from The Netherlands Organisation for Scientific Research (NWO).

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